Weather Note

TWO UNIQUE EASTERN PACIFIC HURRICANES OF 1957

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1. INTRODUCTION

Most storms forming in the area southwest of Manzanillo, Mexico begin moving westward, but quickly recurve, move northward, lose their tropical identity, and fill rapidly. A few, with a higher energy level than usual, or supplemented by extratropical systems to the north, move far enough to the north to bring rain, and less often, high winds to southern California. Others curve to the northeast and move toward or into Mexico until they dissipate. At least one crossed into the Gulf of Mexico [1], moved over that body of water, and reached Florida. A very few do not recurve at all, but continue a general westward movement. In 1957 two of these latter progressed far beyond the normal paths.

This paper attempts to analyze these storms, in some measure to explain the reasons for westward movement, and to evaluate conditions which caused the early demise of the first, Kanoa, and the intensification of the second at a latitude where normally a change to extratropical type of storm would be expected.

Analysis and evaluation were severely limited by lack of data. Unlike the Caribbean-Atlantic and the western Pacific areas where many previous studies have been made on tropical storms, the area between Hawaii and Mexico is completely without upper air data and virtually without surface data. These limitations preclude accurate application of suggested forecast techniques for long periods in the lives of the storms, or may even rule out an approach completely. An example of this is clearly shown in the case of Kanoa, where the Riehl-Haggard [2] method was inapplicable because the southern part of the grid extended into an area where even normal height charts are subject to suspicion.

2. THE FIRST STORM, KANOA

Kanoa was first recognized in a bulletin issued by the San Francisco Weather Bureau office at 0700 GMT, July 15, 1957. The bulletin, based largely on a report from the ship *Gravel Park*, which reported a westerly wind of 45 knots and a pressure of 998 mb. at 2000 GMT, July 14, placed the center about 750 miles southwest of Manzanillo, Mexico. The San Francisco office continued issuing bulletins until 0900 GMT, July 18, when lack of data forced abandonment.

However, three days later, at 0300 GMT, July 21, the ship *Cape Horn*, located near 15° N., 130° W., reported 67 m.p.h. winds and very high seas with precipitous swells. On receipt of this information, the San Francisco office resumed issuance of advisories, now raising the storm into the hurricane category. The *Cape Horn* remained either in or on the periphery of the storm for the following four days, rendering invaluable aid in charting the course and intensity of the storm.

On July 22, a plane from the 57th Weather Reconnaissance Squadron, Hickam Air Force Base, Oahu, located the eye, about 40 mi. in diameter, and estimated the maximum sustained winds to be 70 kt. with gusts to 100 kt. The next day the ship *Elba* added reports that were extremely helpful in the analysis of the situation. The Air Force reconnaissance continued daily until the storm filled and winds dropped below 35 kt.

Normally, data southeast of Hawaii are conspicuous by their virtual absence. In this case, though, Kanoa travelled almost the same path as the shipping lane between Hawaii and the Canal Zone. This coincidence provided enough data to allow excellent results in forecasting movement and character of the storm.

As the storm neared the 140th meridian, the Weather Bureau office in San Francisco transferred responsibility for issuance of advisories to the Weather Bureau in Honolulu. The Hawaiian military meteorological offices, responsible for slightly different areas than the Weather Bureau, had already begun issuing their warnings, and had named the storm Kanoa, a Hawaiian word meaning loosely "the free one."

As Kanoa approached the 145th meridian, it became apparent that there would be little or no chance for recurvature as the semipermanent Pacific High was strengthening to the north, and ridging farther westward (figs. 1, 2). This formed an effective block, such as is suggested by Simpson [3], at least in the lower layers. Aloft, a Low formed just to the northeast of the Islands, and was later reinforced by colder air from a trough

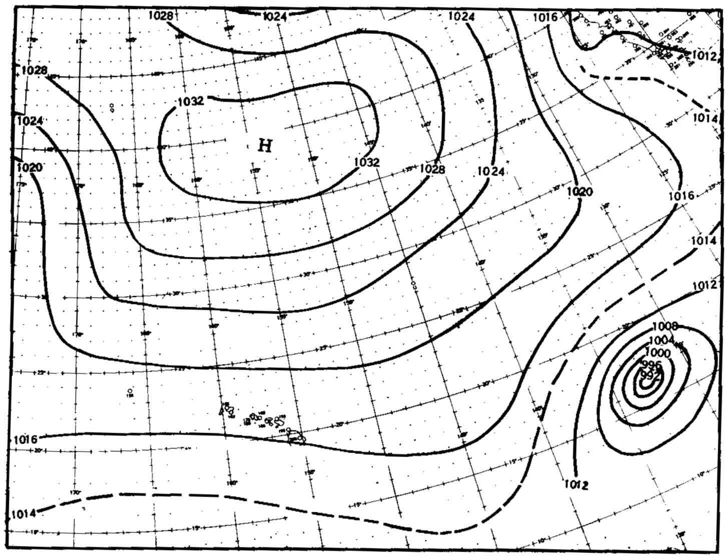

FIGURE 1.—Sea level pressure (mb.), 1200 GMT, July 21, 1957.

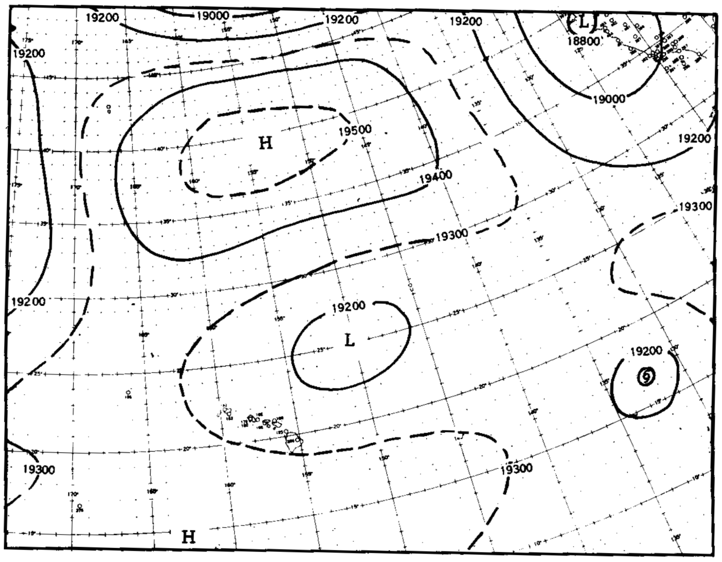

FIGURE 3.—500-mb. height (ft.), 1200 GMT, July 21, 1957.

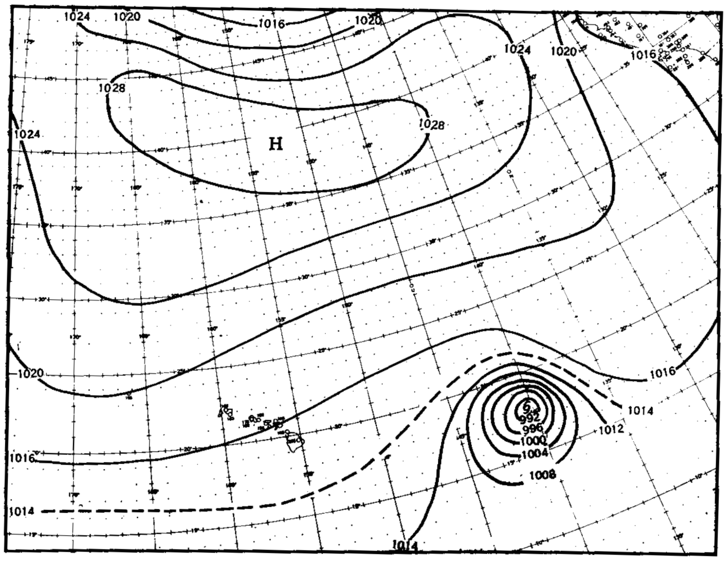

FIGURE 2.—Sea level pressure (mb.), 1200 GMT, July 23, 1957.

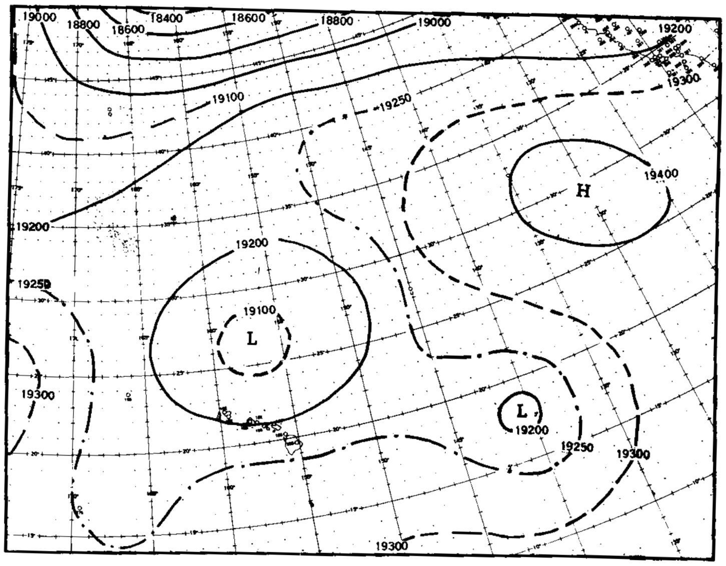

FIGURE 4.—500-mb. height (ft.), 1200 GMT, July 23, 1957.

extending southwestward from the vicinity of the Aleutians (figs. 3, 4). With the lower-level pattern forcing Kanoa to remain on a track with a westward component, but with the upper air picture suggesting that colder air would alter the characteristics of the tropical storm, the life of Kanoa as a hurricane was doomed. It weakened steadily, and the portion above 10,000 ft. or so was incorporated into the cold trough. By July 23, the storm at 700 mb. was part of a broad trough in the easterlies which had several lesser but distinct closed circulations (fig. 5). The part below 10,000 ft. continued its westward movement, filling rapidly. By the time it had reached the Hawaiian Islands, it was little more than a perturbation in the easterly flow (fig. 6). However, it caused a marked increase in rainfall over Hawaii, though the rain fell in a nearly normal trade wind pattern. A less pronounced increase in surface winds was also observed.

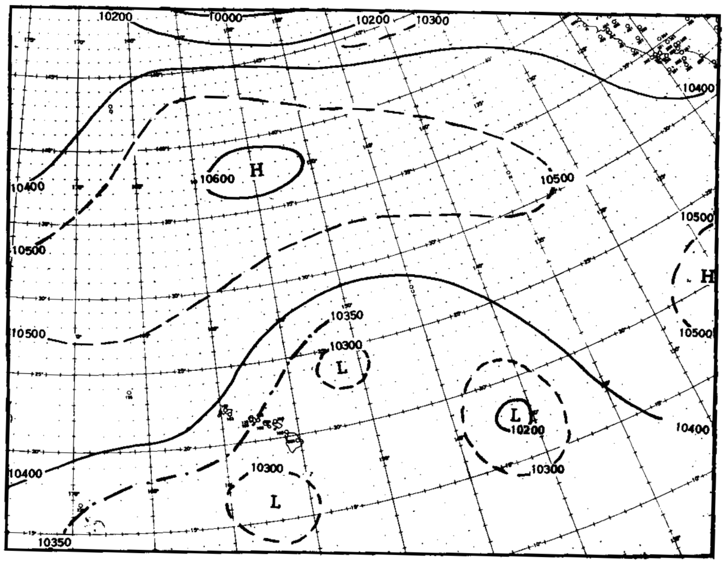

FIGURE 5.—700-mb. height (ft.), 1200 GMT, July 23, 1957.

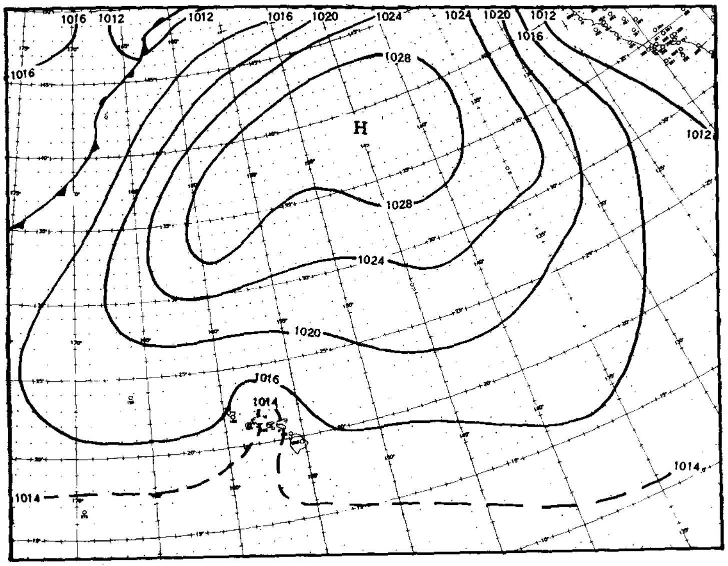

FIGURE 6.—Sea level pressure (mb.), 1200 GMT, July 26, 1957.

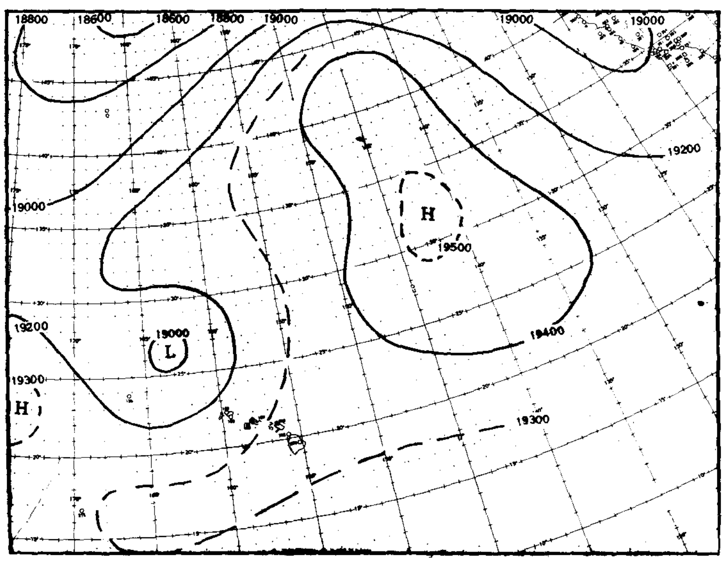

FIGURE 7.—500-mb. height (ft.), 1200 GMT, July 26, 1957.

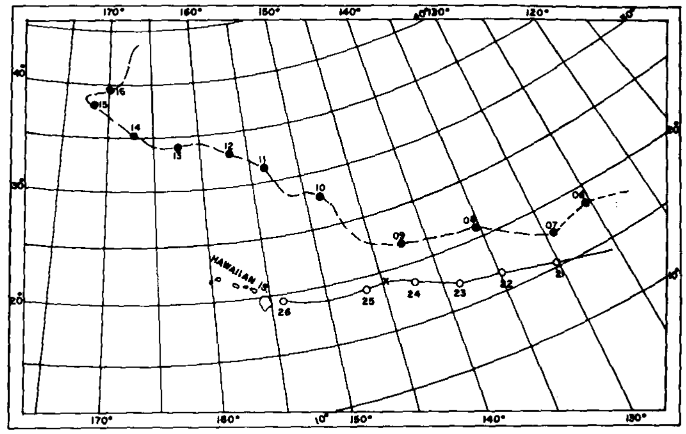

FIGURE 8.—Tracks of the two storms: Kanoa, July 21–26, 1957, solid lines; the unnamed storm, August 6–16, 1957, dashed lines. Positions are for 0000 GMT.

Meanwhile, at the 500-mb. level, the circulation of Kanoa had been absorbed by the large cold Low so well that little or no evidence of Kanoa's existence remained (fig. 7).

Among the more interesting features of this storm was the regularity of movement which it exhibited. In its early stages, it moved at about 8 m.p.h. and accelerated slowly to about 12 m.p.h. and continued at that speed throughout the rest of its existence.

An attempted analysis of sea surface temperatures suggested by [4] was abandoned because no data were available.

3. THE SECOND STORM

HISTORY

About two weeks following Kanoa another tropical disturbance formed in roughly the same area, and crossed the 135th meridian at about 21° N., some 250 mi. north of Kanoa's crossing of this line. From this meridian movements of both storms were parallel for the next 600 mi., each progressing slightly north of west.

Somewhere near the 145th meridian, this second storm turned sharply to the north-northwest and accelerated for a 12-hour period (fig. 8). From analysis of charts during this period, it appeared that cold air had entered the vortex of the storm, and that it was rapidly becoming extratropical. As it crossed the flight path of Hawaii-California planes during this period, revisions of flight forecasts were necessary due to rapid and significant changes in both flight weather and winds. Winds reported by aircraft increased in speed with height in the atmosphere, so this lent support to the analysis that the storm was becoming extratropical. Certain analysis was impossible because necessary data were not available; however, after this relatively short period, the storm again slowed down, and there was considerable evidence (notably winds and temperatures reported by the Air Force reconnaissance plane which surveyed the storm) either that it had regenerated or that previous analyses had been in error. The storm was very small, since surface craft no more than 100 mi. from the eye reported no winds over 25 kt., and no adverse weather. Twenty-four hours after the deceleration began, the storm had intensified into a full-fledged hurricane (fig. 9).

For the next four days the storm maintained hurricane strength, and moved in a general northwestward direction. The maximum reported surface wind occured at 35.3° N., 166.5° W. at 1800 GMT, August 13 (fig. 10); the ship *Jean Lafitte*, apparently passing very near the center, reported a southerly wind of 90 kt. and surface pressure of 999 mb. It was not until the storm had reached a latitude of about 38° N. that it lost its tropical characteristics and moved rapidly away to the northeast (fig. 11).

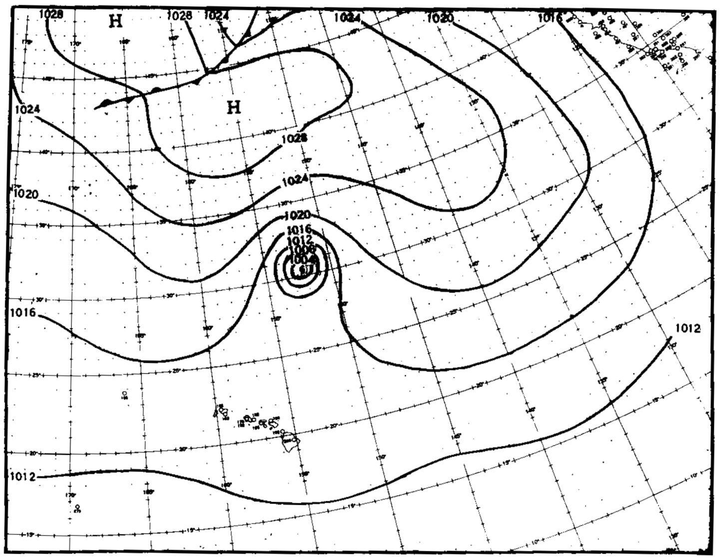

Figure 9.—Sea level pressure (mb.), 1800 gmt, August 10, 1957.

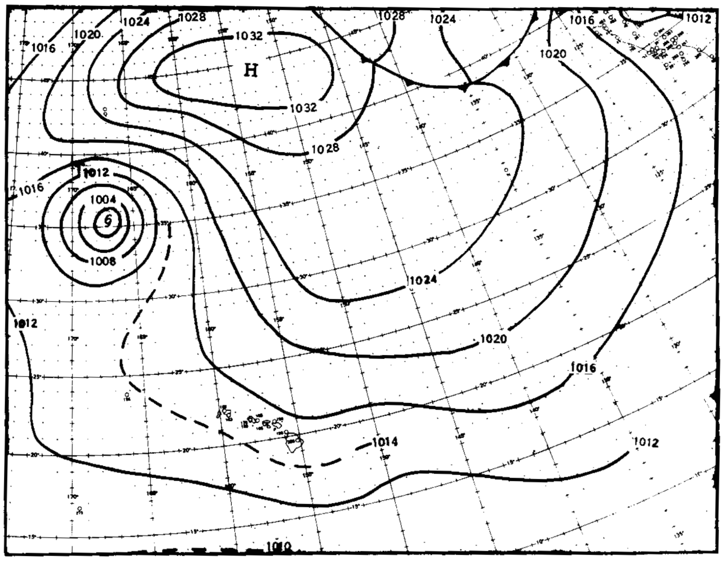

Figure 10.—Sea level pressure (mb.), 1800 gmt, August 13, 1957.

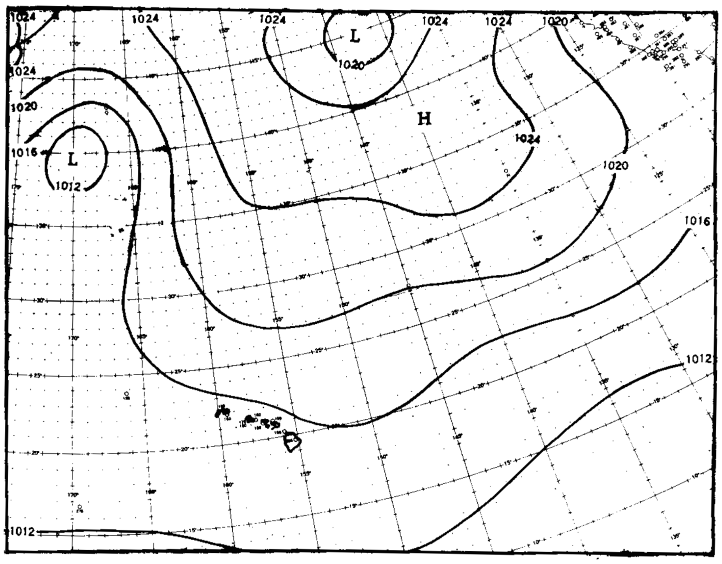

Figure 11.—Sea level pressure (mb.), 1800 gmt, August 15, 1957.

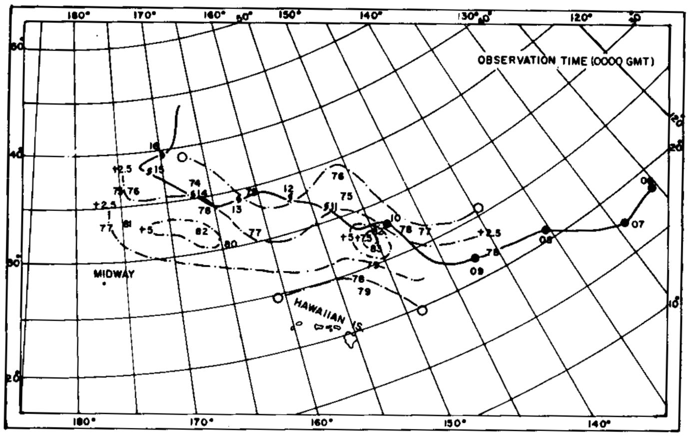

Figure 12.—Departures (dash-dot lines) of reported sea surface temperatures (plotted numbers), August 5–18, 1957, from normal temperatures [5]. The hurricane track is shown by solid line.

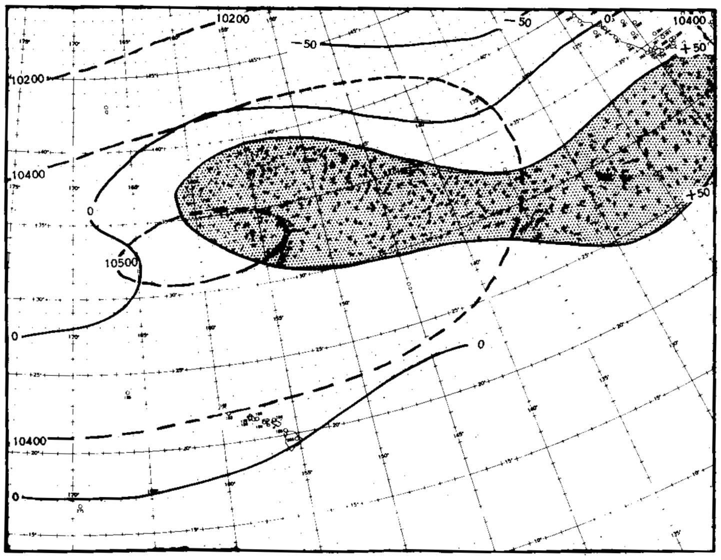

Figure 13.—Departure of mean 700-mb. height for July–August 1957 from normal July–August 700-mb. height. Normal heights are dashed lines, departures from normal, solid lines. Shaded area represents positive departure greater than 50 ft.

SEA SURFACE TEMPERATURE FIELD

Since this storm passed over shipping lanes between the west coast of North America and Hawaii and also between Japan and the United States, enough surface data were obtained for a good analysis of the sea surface temperature field. Sea surface temperatures received during the period from August 5 to 18 were plotted and compared with normals [5] for the month of August (fig. 12).

It appears that the extremely high sea surface temperatures in the area may have been related to deceleration, intensification, and direction of movement of the storm. The maximum deviation from normal temperature occurred in the direction of movement of the storm (fig. 12), and the storm reached hurricane intensity after it had been near this maximum for a period of 12 to 18 hours. So far as existing data indicated, the storm's movement seemed to be roughly parallel to the major axis of the positive temperature anomaly field.

COMPARISON WITH NORMALS

Comparing the mean 700-mb. chart for the months of July and August 1957 with the normals for those months showed that the height anomaly was considerably positive from 22° N. to 35° N. from about 135 °W. eastward into the North American continent, and that the Pacific high cell north of Hawaii was larger than normal and displaced to the east (fig. 13). The normal north-south trough off the west coast of California and Mexico was damped markedly, and a narrow but definite east-west ridge appeared, extending from southern Arizona through northern Baja California, to a point near 28° N., 125° W., then curving northwestward to the high cell northeast of Hawaii. These deviations from normal suggest a change in steering of storms originating during the period: the existing wedge steered the storm on a westward course instead of the more common recurving path northward along the trough line.

4. CONCLUSIONS

The set of conditions which force westward movement beyond the early stages of tropical storms in the eastern North Pacific is so rare that the chance for study of such storms is almost nil. From the meager facts presently available, it appears that the upper air anomalies along the 28th to 32d parallels, and especially the filling of the normal north-south trough off the west coast of North America, are strong contributing factors in causing the initial westward thrust. After the storm passes the area normally most favorable for northward recurvature, the subtropical High seems to act as a steering mechanism, until such time as other factors overcome the strength of this steering wedge and either cause or allow recurvature.

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